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ABSTRACT

Discussed are the difficulties that entering college freshmen seem to have with mathematics, particularly with fractional forms. A success-oriented program is suggested in which all students are successful. To obtain this goal, a number of alternative routes are discussed such as presenting decimals before fractional forms and the use of the calculator which uses a decimal format. (MP)

DECIMALS TAKE A NEW AND DOMINATE ROLE IN THE CURRICULUM

by John J. Edgell, Jr.

Common complaints among my colleagues are that administrative admittance standards are lower, seemingly bright and academically prepared students are rare, students seem to have lost the art of study and most of them seem to have difficulties with mathematics, particularly with fractional forms. Contrary to reports of the registrar, one suspects that the student population is from this (Diagram 1-normal curve) sector of the graduating seniors of the public schools.

If we start students in courses which we feel are appropriate for college-university credit and geared to complement degree programs both in scope and sequence, we find that we have high attrition rates, lots of complaints from every corner and low student evaluation ratings! Further, we suspect that such pressures eventually lead to erosion of quality of standards.

Now, it may occur to you that I might be associated with unusual circumstances. I suspect not since I have just compared notes with some of you and I've read the "Message From The President"[1] where he refers to the fact that many of the students tend to be "mathematically reluctant." Perhaps meetings like these only

1. Philip M. Cheifetz. "A Message From The President." In: Alice Hagood, Convention Chairman. "Official Program, Annual Meeting, American Mathematical Association of Two Year Colleges." Houston, Texas, 1978.

attract folks who have unusual students. I doubt that also. I sort of sense that the problem is somewhat universal in scope.

By the way, have you ever seen solutions to problems like these? (Diagrams 2,3,4,5,6) You really want to laugh and cry when you see results such as those. By the way, knowing your students as you do, how many would be brave enought to respond correctly in such a sequence of problems?

Apparently we either sacrifice academic virgins to the system or we attempt to bridge the gap between public school preparation and where we would like to start. Consequently, most of us are searching for a miracle course or laboratory situations which will service our students.

Perhaps we ought to reflect upon where our students have been. We may avert some of the same pitfalls and also learn from our primary school colleagues.

Students, upon entering school, are assumed to be normally distributed in many characteristics including mathematically tallented. This may be the first and largest error. That is, to start students in a system which automatically assumes lack of abilities and furnishes us with excuses for not being successful. Perhaps we ought to start then and now with a basic assumption that every student can "do it," a success-oriented program as

described by Bloom[2] and stop furnishing ourselves with excuses when we aren't successful. The next problem is to find a way. Common practice in the past was some sort of linear regimented sequence of topics with at least one way (sometimes at most one way) (Diagram 7) to teach. Students either survived the system, sifted out as failures, or were socially passed on without really experiencing success on the basic principles and subsequent ideas. Essentially we ended up exactly as we predicted, a normal distribution where only a few are really academically prepared. (Diagram 8)

Perhaps we ought not keep everyone together on the same topic, same pace, same model, same teaching strategy, etc. Perhaps we ought to search for alternate routes to the same eventual goals and when we are not successful in teaching, put the blame where it belongs. (Diagram 9)

There are many alternatives on the horizon today. Alternate models, such as money, chip trading games, etc., changes in measuring such as metric measuring, innovative tools such as the hand held calculators and some redesigning of the curriculum such as predicating fractional forms on decimals rather than the reversal are among these alternatives. Some of these changes are geared to helping students understand rational numbers (and fractional forms). By the way, we may be guilty of teaching modes rather than ideas, particularly in the rational number area. (Diagram 10) What I am suggesting are diagnostic efforts on our part to determine

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2. Benjamin S. Bloom. "An Introduction to Mastery Learning Theory." In: J. H. Block, editor. "Schools, Society, and Mastery Learning." New York: Holt, Rinehart and Winston, Inc., 1974.

the appropriate entree level of each student so as to allow each student to begin with confidence. Further, to assume that each student is capable of being successful in mastering the necessary basic skills. Then, to find a way of allowing the individual to achieve and accomplish those skills. Remember, failure only indicates that we haven't discovered the way, yet. (Diagram 11) For instance, back to fractional forms (ordered pairs and indicated divisions) which most of us feel transfers to learning elementary algebra. We have many models, modes and tools available today that were not a part of our background when we were enroute. We need to manipulate these and create others in our efforts to find a way.

Suppose we assume counting numbers as represented by base ten positional numeration is mastered to an acceptable level of excellence. Knowing about the numerals and the standard operations would lead us to believe that not only has the student learned about units, tens, hundreds, etc., particularly ten units is a ten, ten tens is a hundred, ten hundreds is a thousand, but the student can reverse the grouping, which is quite an accomplishment according to Piaget:[3] That is, the student knows that a thousand is ten hundreds, a hundred is ten tens, etc. A student with this pattern may be equiped to eventually take on decimals. The base ten counting numerals in turn serve as a model to build upon. (Diagram 12) Money seems to be a viable part of most everyone's environment. Students have grown up using money. Perhaps money may be a useful

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3. Richard W. Copeland, "How Children Learn Mathematics-Teaching Implications of Piaget's Research." New York: Macmillan Publishing Co., Inc., 1974. Chapter 6.

model. Let's see, we have pennies, ten pennies is a dime, ten dimes is a dollar, ten dollars is a sawbuck, ten sawbucks is a C-note, etc. Again, reversing is probably easy. That is, a C-note is ten sawbucks, a sawbuck is ten dollars, a dollar is ten dimes, and a dime is ten pennies. (Diagram 13) In fact, one may even recognize a dollar as one hundred pennies or a C-note as a hundred dollars or a thousand dimes, etc. Which may or may not be of some use to us later. Now, dollars as a model is really a rather specific model of chip trading. Such as, a red chip may replace ten white chips, a blue chip may replace ten red chips, etc. Again we can note the reverse. (Diagram 14) Similarly, the metric system, say the linear part, may furnish us with a similar model. That is, as suggested by some early childhood researchers, ten decimeters is a meter, ten meters is a decameter, ten decameters is a hectometer, etc. (Diagram 15)

Or consider the hand held calculator! Ten punches on one is ten, ten punches on ten is a hundred, etc. The National Council of Teachers of Mathematics has investigated extensively the role of the hand held calculator in the classroom and seems about ready to take a positive stand.

Notice that I have not mentioned or demonstrated some way of denoting the base unit. We happen to denote the base unit, one, by writing a dot (called a decimal point) to the right of the unit position. The dot or point does not change the relationships of a unit to the left is ten of those to the right or the reverse.

Unlike the Greeks, we don't really mind what may be chosen as a basic unit and then assign number values. Admittedly not all students will learn from these "hands on" "real world" related activities and be able to capitalize on the power of patterns and transfer, but this is a way and there are others.

What next? Applying properties very similar to those experienced when operating with counting numbers, using base ten numerals, dollars, chips, measuring and verifications on the calculator, one can master the basic skills using decimals.

Now, one may introduce fractions as ordered pairs (indicated division) in terms of decimals, rather than the reverse. By the way, Swafford,[4] at the 56th Annual NCTM meeting in San Diego this spring, indicated the Swedish Curriculum is organized to have decimals preceed fractions and that the Addison & Wesley text book series has a similar development. I've noticed just recently that the Harcourt, Brace and Javonovich texts are developed similarly. I choose to emphasize the metric system as a model because of the recent trend of implementing the metric system of measuring into the curriculum.

Although I've mentioned the hand held calculator as a possible (perhaps weak) model in a developmental sequence leading to mastery of decimals, let me emphasize a couple of other advantages.

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4 Jane O. Swafford, "Decimals befor Fractions: Can, and Should It Be Done?", Official Program, "56th Annual Meeting National Council of Teachers of Mathematics," 1978

One obvious feature is that the face lights up in the decimal format. Another feature is that one can perform the basic skills on the tool, almost instantly. This feature lends itself as a support instrument when we encounter elementary algebra. Students can gain confidence quite often by interpreting polynomials as decinomials, that is, substitute ten for x and check the form using decimal arithmetic. Moreover, with the calculator a student can verify algebraic forms in a matter of secnds (and, of course, no written evidence). Further, we generally ask students to complete the biconditional sequence by checking. Why not a calculator check? Of course, there are many more places for the hand held calculator in our curriculum.

To wrap up, let us admit that presently we are seeing failure, overwhelming failure in our mathematics courses. We can either write off these students and excuse ourselves or we can responsibly attempt to find alternate strategies and reach success as professionsls.

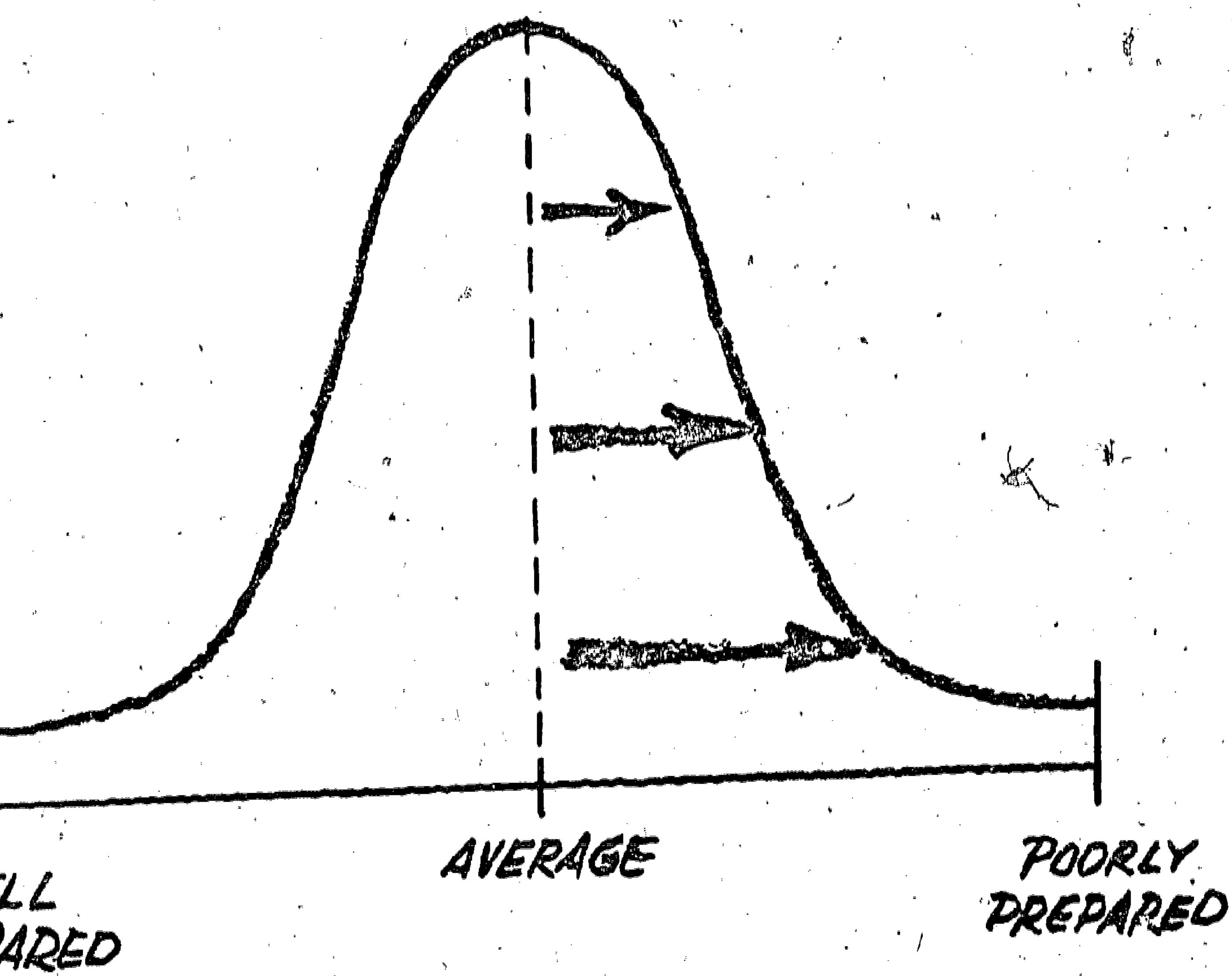


Diagram 1

1. $3\frac{3}{4} \times 3\frac{1}{5} =$

a) $9\frac{3}{20}$

b) $\frac{15}{4} \times \frac{5}{16} = \frac{75}{64} = 1\frac{11}{64}$

c) $\frac{\overset{3}{\cancel{15}}}{\cancel{4}} \times \frac{\overset{4}{\cancel{16}}}{\cancel{5}}$

d) $3\frac{5}{20} \times 3\frac{4}{20} = 9\frac{20}{20} = 10$

e) None of these

Diagram 2

$3\frac{1}{7} \div 2\frac{1}{5} =$

a) $3\frac{1}{7} \times 2\frac{5}{1} = 6\frac{5}{7}$

b) $\frac{22}{7} \div \frac{11}{5} = \frac{\overset{2}{22}}{7} \times \frac{5}{\cancel{11}} = \frac{10}{14} = 1\frac{4}{14}$

c) $\frac{22}{7} \times \frac{11}{5} = \frac{242}{35}$ improper, so can't divide

d) $3 \div 2 + \frac{1}{7} \div \frac{1}{5} = 3 \times \frac{1}{2} + \frac{1}{7} \times \frac{5}{1} =$

$\frac{3}{2} + \frac{5}{7} = \frac{8}{9}$

e) None of these

Diagram 3

3. $5\frac{2}{9} + 4\frac{4}{9} =$

a) $1\frac{6}{9} = 6$

b) $9\frac{8}{9}$

c) $\frac{47}{9} + \frac{40}{9} = \frac{1880}{9} = 208\frac{8}{9}$

d) $\frac{47}{9} + \frac{40}{9} = \frac{87}{18} = 4\frac{15}{18} = 4\frac{5}{6}$

e) None of these

Diagram 4

$7\frac{1}{7} - 3\frac{8}{14} =$

a) $4\frac{7}{7} = 5$

b) $7\frac{2}{14} - 3\frac{8}{14} = 4\frac{6}{14} = 4\frac{3}{7}$

c) $\frac{50}{7} - \frac{50}{14} = \frac{0}{7} = 0$

d) $\frac{\cancel{50}}{\cancel{7}} - \frac{\cancel{14}^{2}}{\cancel{50}} = 2$

e) None of these

Diagram 5

5. $-5\frac{1}{4} = 4\frac{3}{4}$

a) True

b) False

c) None of these

Diagram 6

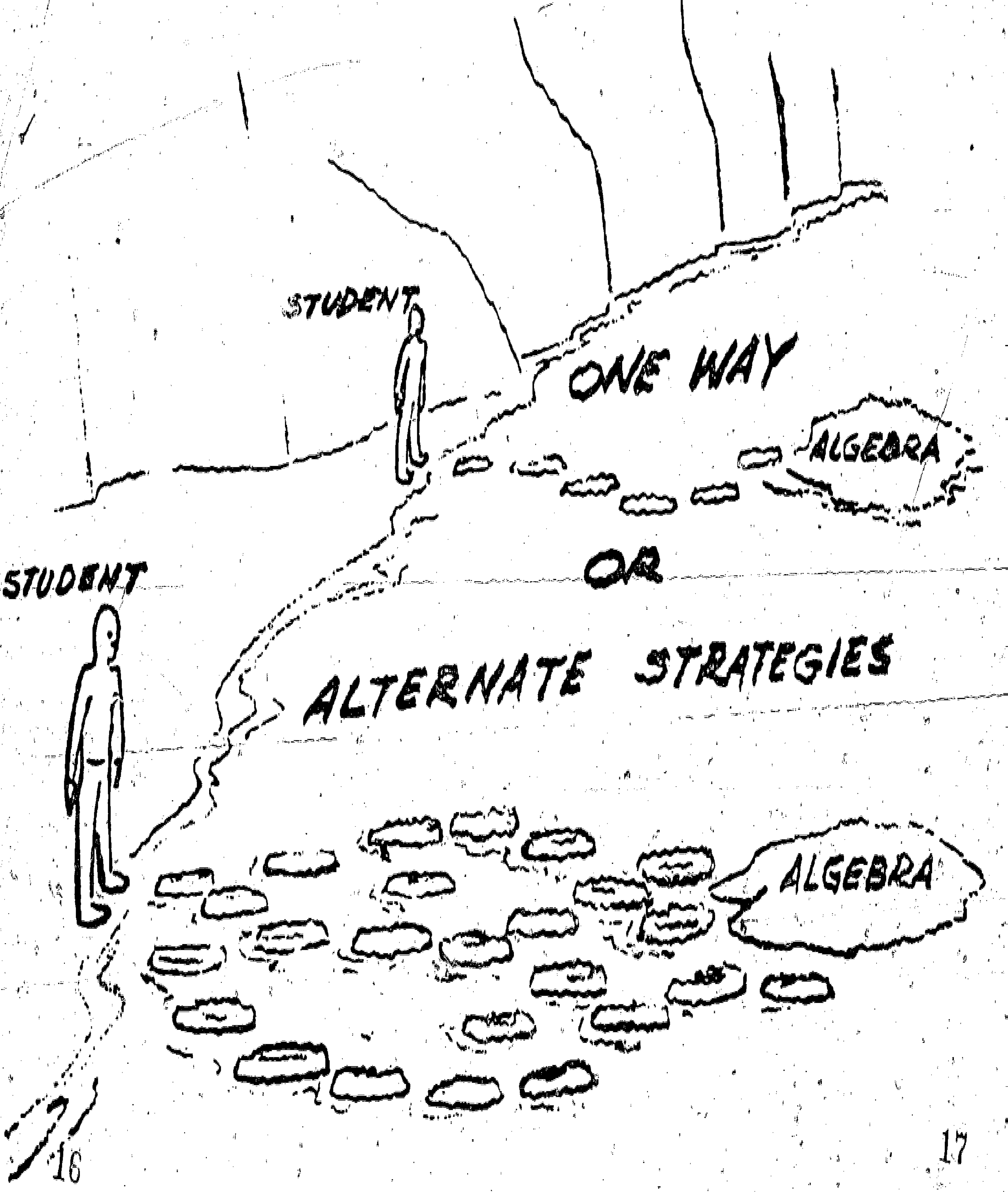

STUDENT
ONE WAY
ALGEBRA
STUDENT
OR
ALTERNATE STRATEGIES
ALGEBRA

Diagram 7

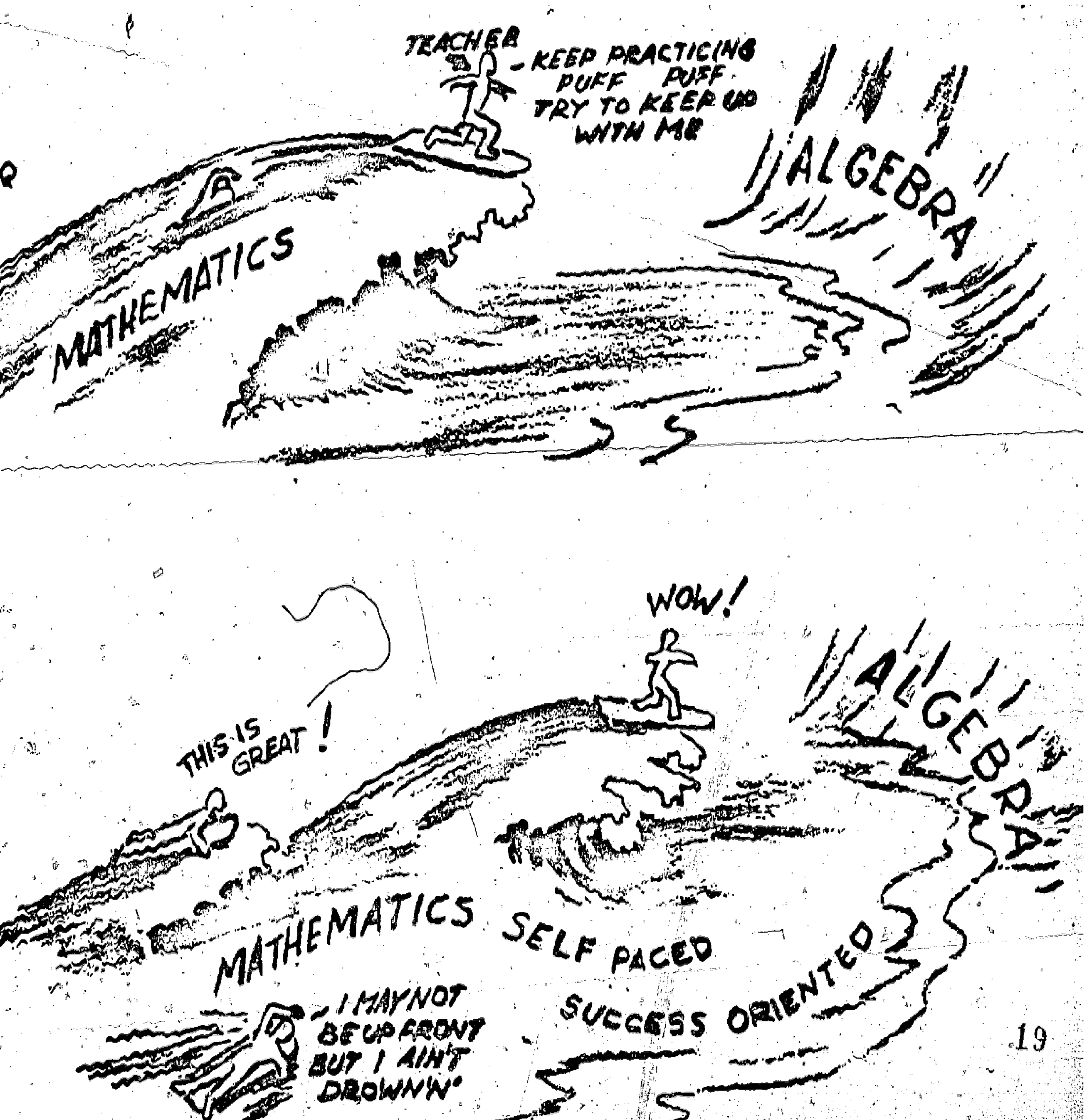

TEACHER
- KEEP PRACTICING
PUFF PUFF
TRY TO KEEP UP
WITH ME
ALGEBRA
MATHEMATICS
WOW!
THIS IS GREAT!
ALGEBRA
MATHEMATICS SELF PACED
SUCCESS ORIENTED
- I MAY NOT
BE UP FRONT
BUT I AIN'T
DROWN'N'

Diagram 8

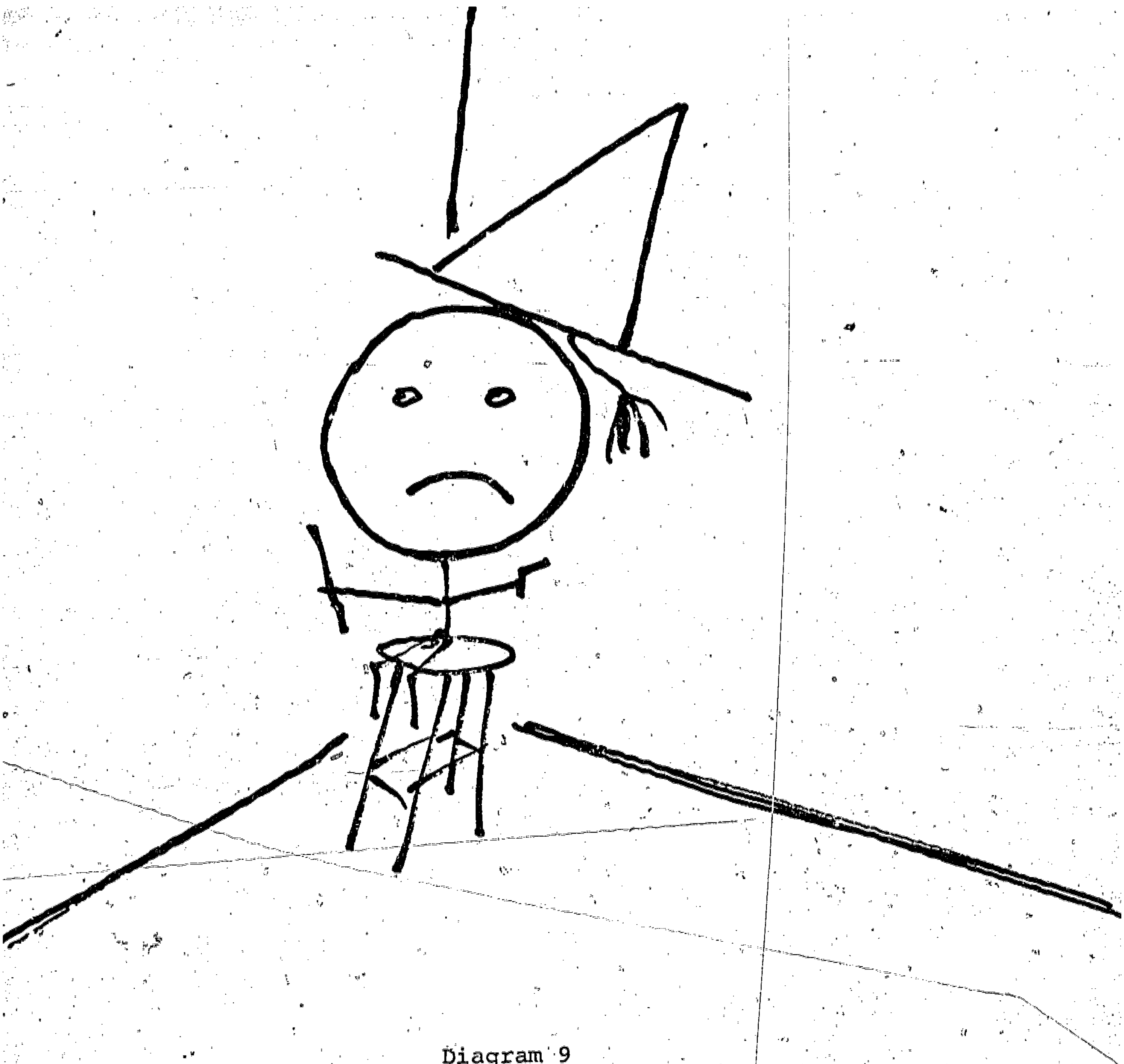


Diagram 9

Rational Numbers or Mode?

Fraction (ordered pair) $1 - \frac{1}{2}$

\$ 1 dollar - 50 pennies

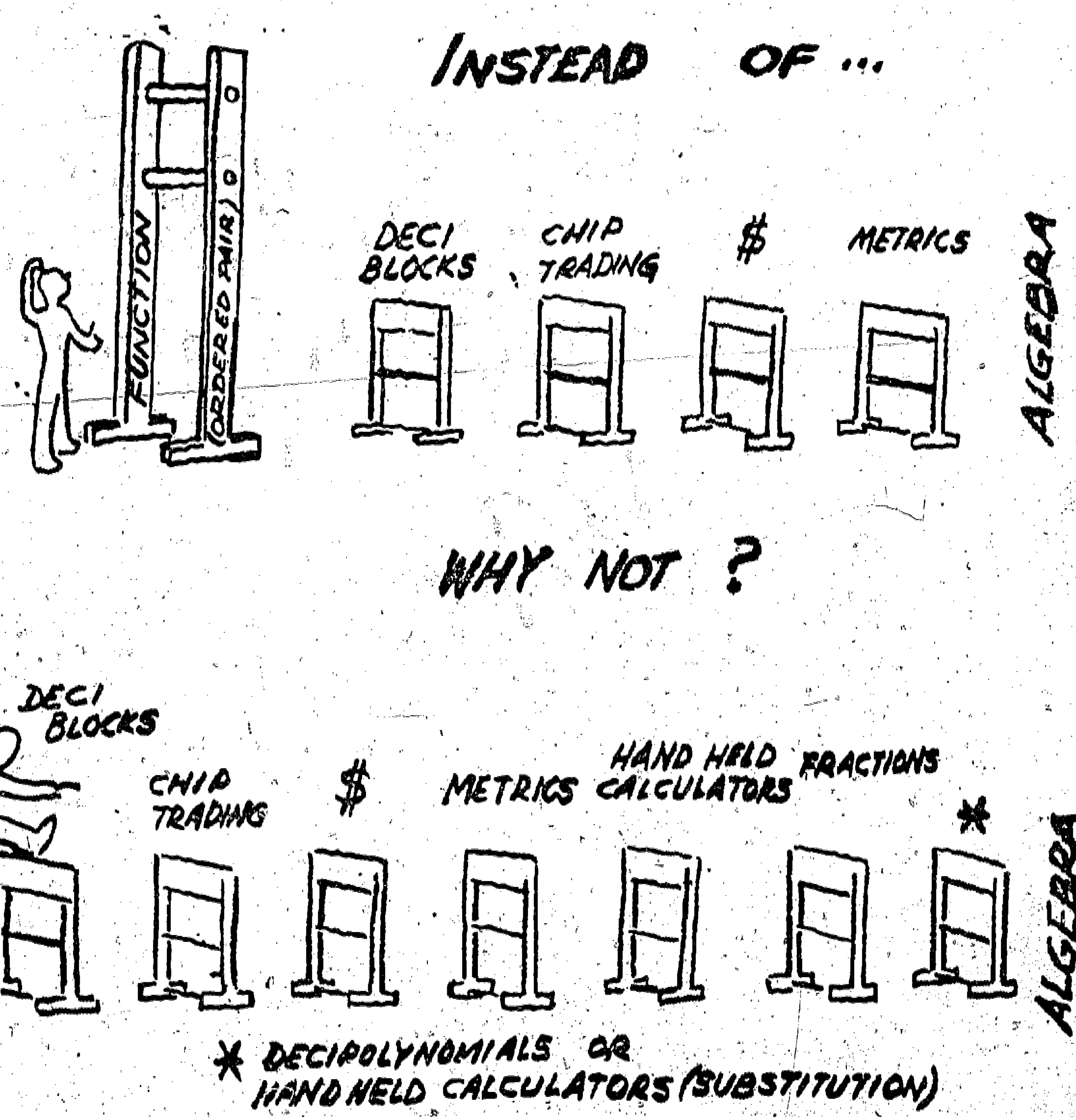
Meters 1 meter - 50 centimeters

Calculators 1.0000000 - .5000000

Success!

21 22

Diagram 10


INSTEAD OF ...
FUNCTION
(ORDERED PAIR)
DECI BLOCKS
CHIP TRADING
$
METRICS
ALGEBRA
WHY NOT ?
DECI BLOCKS
CHIP TRADING
$
METRICS
HAND HELD CALCULATORS
FRACTIONS
*
ALGEBRA
* DECIPOLYNOMIALS OR
HAND HELD CALCULATORS (SUBSTITUTION)

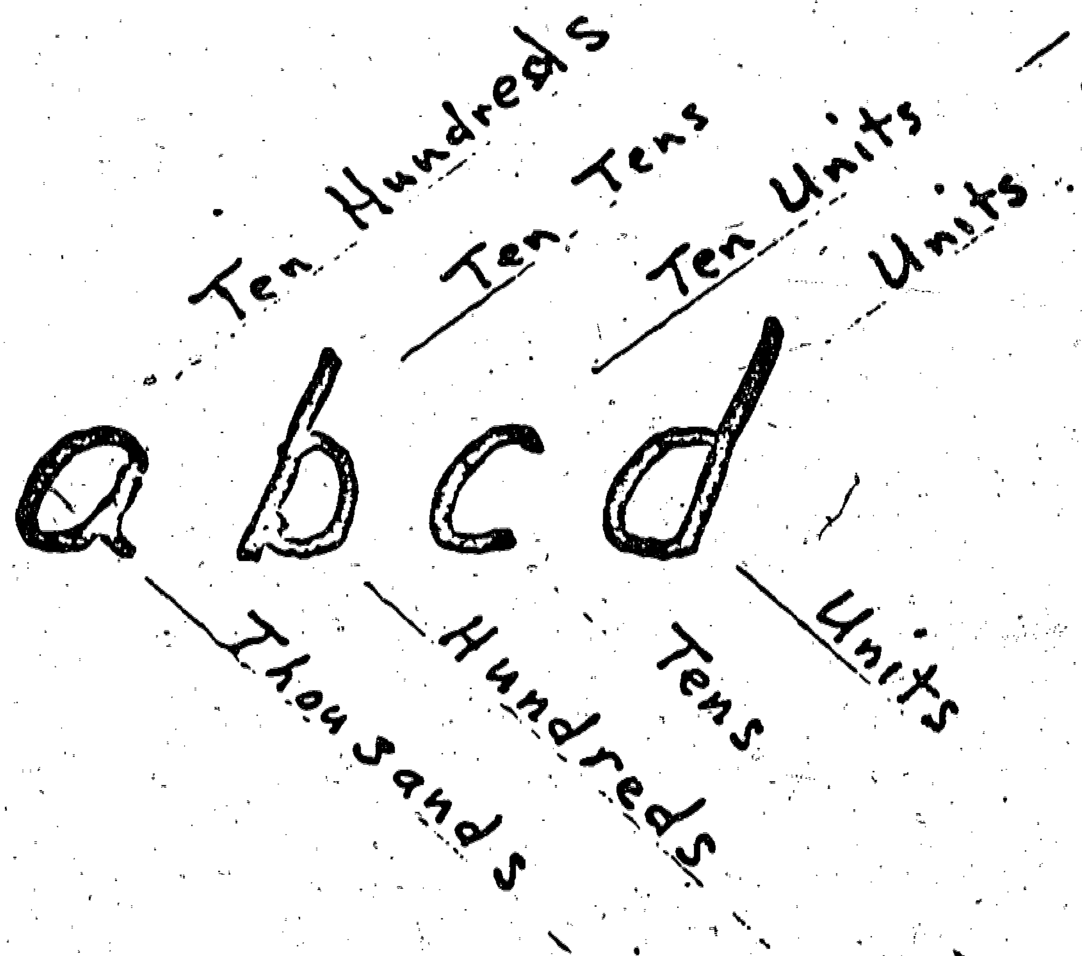

Ten Hundreds
Ten Tens
Ten Units
Units
abcd
Thousands
Hundreds
Tens
Units

Diagram 12

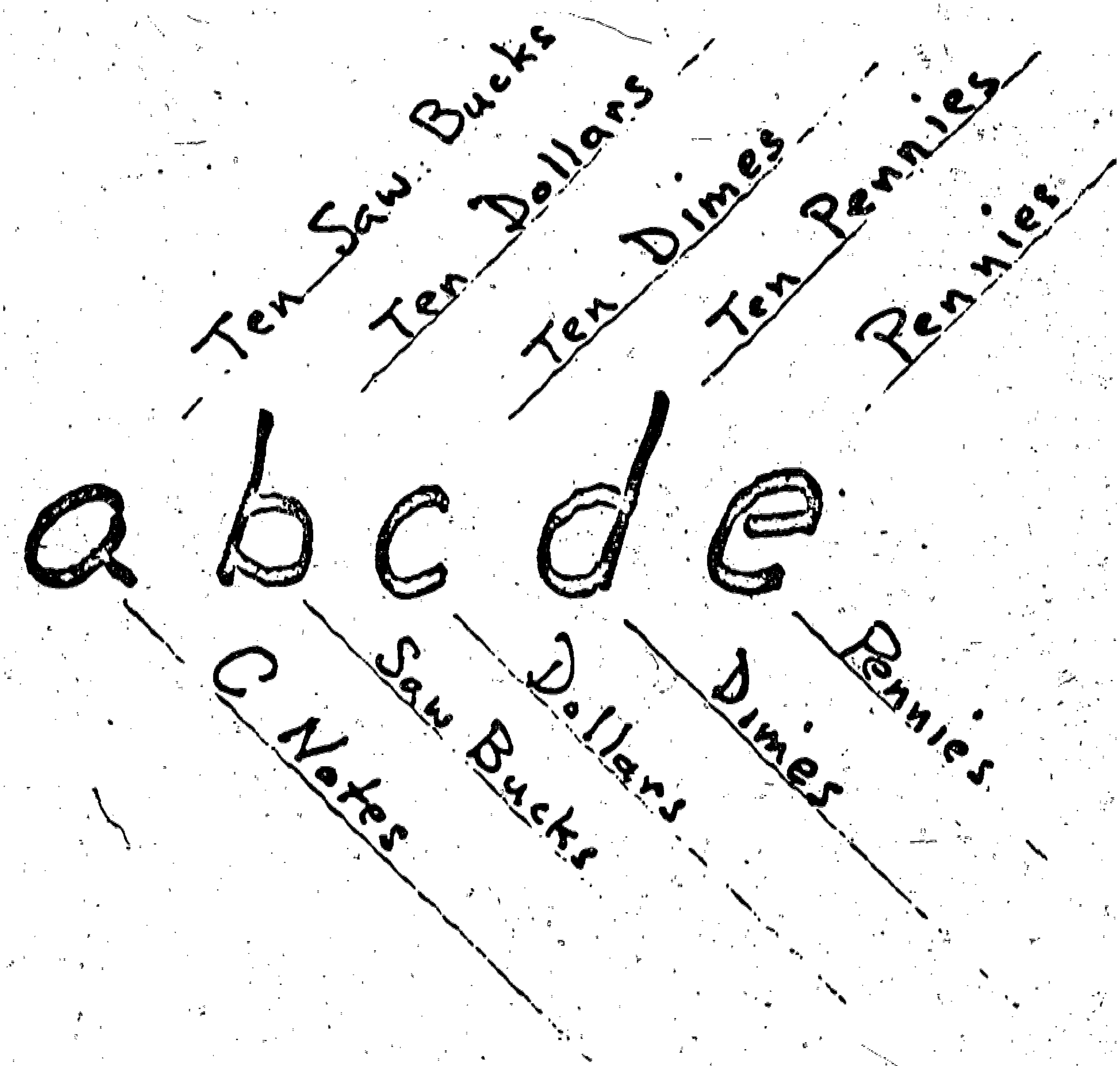

Ten Saw Bucks
Ten Dollars
Ten Dimes
Ten Pennies
Pennies
a b c d e
C Notes
Saw Bucks
Dollars
Dimes
Pennies

Diagram 13

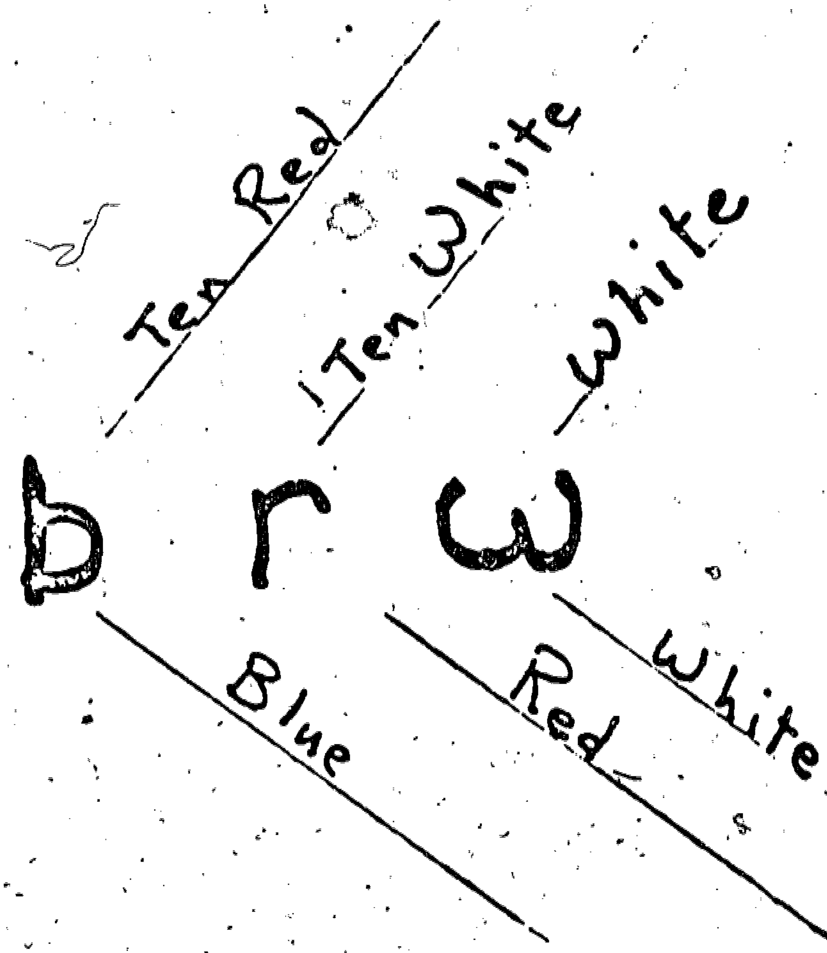


Diagram 14

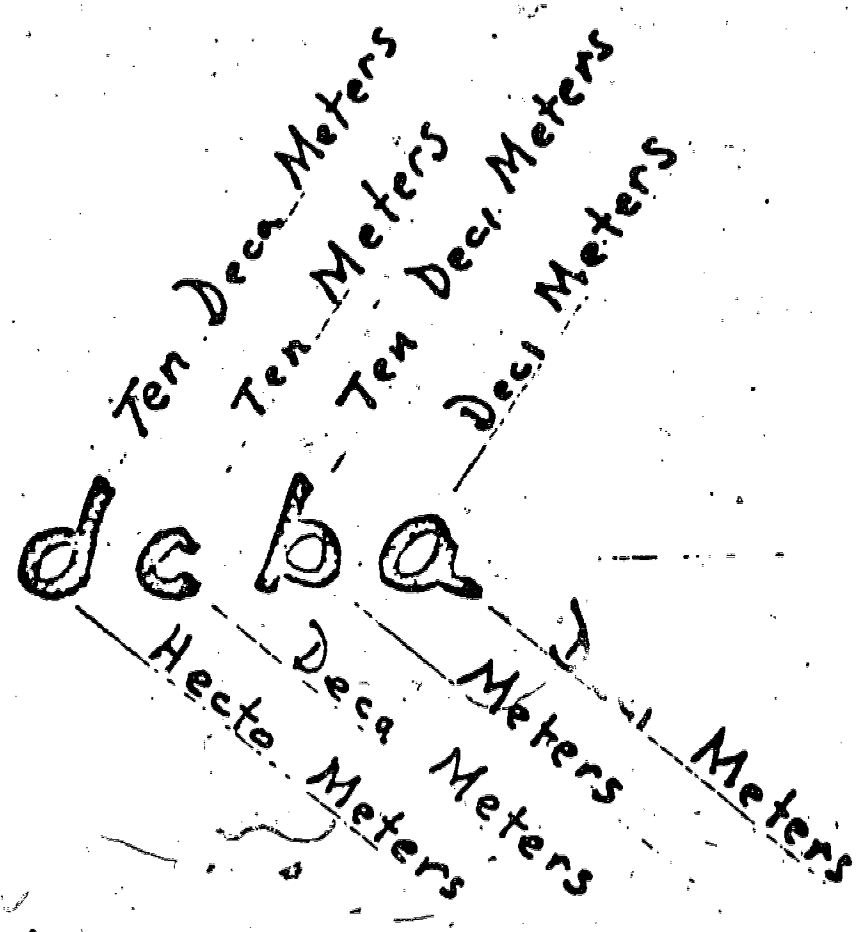

d c b a
Ten Deca Meters
Ten Meters
Ten Deci Meters
Deci Meters
Hecto Meters
Deca Meters
Meters
Meters

Diagram 15